E.M.B.13

GRAPEFRUIT CULTURE IN THE BRITISH WEST INDIES AND BRITISH HONDURAS

By Professor H. CLARK POWELL, B.Sc.,
Professor of Horticulture, Transvaal University College, Pretoria.

DECEMBER, 1928

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PREFACE.

On receipt of applications from certain Colonies for financial assistance in developing citrus fruit cultivation and export, the Empire Marketing Board felt the need for a general review of the prospects of citrus production in the Colonial Empire. The cultivation of oranges and grapefruit in the Empire was seen to present many problems alike of horticulture, of transport, and of marketing, and the Board decided to arrange for a citrus specialist to pay a visit to the principal fruit exporting countries of the Colonial Empire to advise as to their methods of cultivation and marketing, and to guide the Board in considering applications for grants.

Accordingly, in August, 1927, the Board invited Professor H. Clark Powell, Professor of Horticulture at the Transvaal University College, Pretoria, and Technical Adviser to the South African Co-operative Citrus Exchange, to investigate the problems relating to citrus fruit cultivation in various Empire countries.

With the concurrence of the Transvaal University College and the South African Co-operative Citrus Exchange, Professor Clark Powell was fortunately able to accept the Board's invitation, and in view of the value of the proposed tour to South African Citrus Growers, the South African Co-operative Citrus Exchange generously contributed £200 towards the expenses of his journey, the balance being provided by a grant from the Empire Marketing Fund.

He first visited Palestine, Cyprus and Zanzibar and submitted Reports to the Governments concerned and to the Board.

The survey which follows deals with grapefruit culture in the West Indies and British Honduras, and contains, in addition, notes on the various Colonies visited. It was also arranged for Professor Clark Powell to visit and study for comparative purposes the citrus-growing districts of California and Florida. He has furnished to each Colonial Government and to the Board more detailed reports on the results of his investigations.

It may be anticipated that the report, envisaging as it does the possibilities of the establishment of a remunerative grapefruit industry, will be received with satisfaction in the West Indies. It should give encouragement especially to those Colonies in which a new industry is urgently needed to provide an alternative to a languishing staple crop ; but to all it should provide an additional opportunity for economic development whereby they may be able to contribute towards meeting the growing demand in this country for fruit produced within the Empire.

EDWARD DAVSON,
Chairman of Colonial Fruit Grants Committee.

Empire Marketing Board.
November, 1928.

GRAPEFRUIT CULTURE IN THE BRITISH WEST INDIES AND BRITISH HONDURAS.

Introduction.

NATURAL conditions of climate and soil are more favourable in the West Indies for grapefruit growing than in any of the countries in which the bulk of the grapefruit of the world is produced. California, Arizona, Texas and Florida are handicapped by unfavourable factors such as low rainfall, high-priced land, the need for extensive fumigation or spraying and expensive soil fertilization. The rainfall in the West Indies is sufficiently high to eliminate any necessity for irrigation ; the soil is very fertile and its fertility can be maintained in a much cheaper manner than in any of the areas mentioned. Abundant land can be purchased at a low cost. Pest control is more economical than in semi-arid countries. As a result of these most favourable natural conditions, grapefruit can be produced in the West Indies at a very low cost.

During the past few years the world's production of grapefruit has increased rapidly and a greater increase will come in the next few years, as can be seen by reference to Table 1. Through a consideration of these figures alone, it would seem unwise to carry out any further expansion of grapefruit production but with these figures should be considered the factor of production costs and delivered cost in the consuming markets. The bulk of the world's grapefruit supply is produced in the United States and it is in this country that production costs are highest. A marked increase in production is taking place in the United States which will result in increased exports to the United Kingdom. The markets for the West Indies are the United Kingdom and Canada and in both of these markets West Indian grapefruit can be landed and sold at a lower cost than grapefruit from the United States.

TABLE 1.

Grapefruit Acreage in Various Producing Areas.

Area.	*Bearing.*	*Non-bearing.*	*Total Acreage.*
Florida . . .	60,651	19,610	80,261
California . . .	5,417	4,187	9,604
Texas	7,000	35,000	42,000
Arizona . . .	1,200	900	2,100
Isle of Pines . . .	10,270	2,900	13,170
Porto Rico . . .	3,145	615	3,760
Total . .	87,683	63,212	150,895

(Figures from Florida Citrus Exchange Statistical Bulletin, 1926–27.)

California, Arizona and Texas cannot land and sell grapefruit in the United Kingdom markets for less than 18*s*. a box. Their costs in the eastern Canadian markets are approximately 16*s*. a box. Florida, the Isle of Pines and Porto Rico cannot land and sell their grapefruit in the United Kingdom for less than 15*s*. to 16*s*. a box, and in Canada their delivered costs are about 14*s*. a box.

The following figures are considered to be representative of general costs throughout the West Indies :—

	Per Box. s.	d.
Cost of production	1	6
Picking, transport, packing	4	6
Freight to London	4	0
London charges and commission . . .	3	6
Total . .	13	6

The landed cost of West Indian grapefruit in the eastern Canadian markets is slightly less than in London. Further, in Canada the West Indian grapefruit has the advantage of a tariff of one cent (1c.) per pound that is levied against American grapefruit.

Therefore, in spite of the large increase in American grapefruit production that is taking place (87,683 bearing acres and 63,212 acres yet to come into bearing) the West Indian producer has a marked

advantage in his lower delivered cost both in the United Kingdom and in Canada. In the event of over-production, the country that has fruit of good quality, well-packed and marketed properly and that can sell at a lower price than its competitors, is fully justified in continuing or expanding its production.

While, however, the West Indies and British Honduras can land and sell fruit in England at a lower cost than the chief citrus fruit producing countries, it must not be assumed that this fact alone will enable the West Indies or British Honduras to establish a fruit industry. With grapefruit in particular, the well-known brands from Florida, such as Sealdsweet and Blue Goose, have become well-established with the English public and because of their quality and uniformity will always find a market. They must be sold at a higher price than the fruit from the West Indies but unless the West Indies and British Honduras can ship fruit equal to them in every respect, the public will continue to demand the higher priced fruit. Low costs of production and marketing when combined with very careful grading and packing, high quality and sound condition on arrival, will enable the West Indian producers to market an ever-increasing quantity of grapefruit.

Jamaica, Trinidad and British Honduras are at present the chief centres of production of grapefruit in the West Indies, and as the industry in the two latter places is in its infancy, the importance of the initial steps for development can hardly be over-emphasized. Co-operative packing, careful grading, uniformity of product and careful handling should be given continual thought and attention.

The grapefruit is a comparatively new article of commerce. Its uses and consumption have not yet been stabilized. Even in the United States where the annual supply is in the vicinity of 10,000,000 boxes, consumption is increasing rapidly. The grapefruit has gained a place of distinction as a breakfast fruit, as a salad fruit, and grapefruit juice is becoming increasingly popular. A remarkable increase in consumption of grapefruit is occurring in Great Britain, as can be seen from Table 2. It is impossible to estimate the extent to which this increase will go but there is every indication that it will continue for some years. A study of the monthly import figures shows that grapefruit consumption in England is no longer seasonal with the tourist traffic.

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TABLE 2.

*Imports of Grapefruit into the United Kingdom in boxes.**

Year.	*South Africa.*	*British West Indies.*	*Other British Countries.*	*U.S.A.*	*Other Foreign Countries.*	*Total.*
1921 . .	2,440	8,770	254	17,923	4,931	34,318
1922 . .	10,216	8,854	—	30,689	800	50,559
1923 . .	12,509	16,877	1,170	45,105	4,418	80,238
1924 . .	15,768	15,787	925	93,689	4,018	130,186
1925 . .	21,837	28,171	784	200,071	17,353	268,186
1926 . .	20,997	43,486	2,688	239,847	25,939	332,956
1927 . .	23,907	47,493	8,926	501,314	24,829	606,468

The various West Indian islands, notably Jamaica, Trinidad, St. Lucia, Dominica and Grenada, are showing a keen interest in developing or expanding their grapefruit industries. Successful realization of their efforts depends on the producers having adequate knowledge of such factors as soils, sites, nursery work, planting, fertilizers, the care of young groves, the care of bearing groves, picking, grading and packing. Many publications have been issued and several books have been written on citrus fruit culture and its many phases. These publications, excellent as many of them are, have been based for the most part on the factors surrounding orange production under conditions that are totally different to those obtaining in the West Indies. Reference to them for such points as soils, soil fertility, irrigation, fumigation, frost protection or marketing is useless for the West Indian planter. The arid conditions of the southwestern United States (Texas, Arizona and southern California), where the annual rainfall is from 5 inches to 35 inches per year are totally different to the conditions in the West Indies, where the rainfall varies from 50 inches to 250 inches per year. The soils of Florida are characterized by their sandy nature and deficiency in plant food; West Indian soils are typically heavy in texture and extremely rich in plant food and organic matter.

Under such remarkably varying conditions, the factors of production are found to vary just as greatly. The use of publications from Florida or California is, therefore, unwise, as the conclusions therein can easily be misunderstood. This paper is written in an attempt to set down some of the writer's conclusions

* Adapted from Empire Marketing Board Fruit Intelligence Notes, Feb. 22, 1928, on the basis of 70 lbs. per box.

and observations gained during a study of citrus fruit conditions in the West Indies. As the remarks are based solely on observation, it must be considered that they are not final. Experimental work and further experience of the planters and local Departments of Agriculture will no doubt result in some modification of the points given herewith. However, until further evidence is available, it is hoped that this paper will prove of some value to the countries of which it treats, namely, Trinidad, Dominica, St. Lucia and Grenada. The general remarks apply equally as well to Jamaica and to British Honduras.

Soils—Rainfall—Site.

The best soils for grapefruit are deep, medium-textured loams that are fertile and well-drained. There is an abundance of such soil in the West Indies. In British Honduras the alluvial loams of the Stann Creek Valley can be mentioned as examples of excellent soil. In the same country, the soils along the lower reaches of the Sibun and Belize rivers can be noted as examples of undesirable soils. They are too heavy, too shallow and too poorly drained to justify their use for any commercial planting of grapefruit.

In Trinidad, as examples of good soil, can be mentioned the site of the Agostini grove near the Pitch Lake and the alluvial soils in some of the valleys east of Port-of-Spain. Sandy soils, such as are found near Siparia, will produce abundant fruit crops, but to do so they require constant fertilization and their use should be deferred until the better soils have been utilized.

Dominica possesses a great abundance of suitable soil. The Fond Hunt lands near Portsmouth, the Layau Valley and many other areas are extremely suitable for grapefruit growing.

Florida soils are very sandy, many of them being practically all sand, and because of their light nature and deficiency in plant food, the Florida growers must use 60 to 90 pounds of commercial fertilizers per tree per year. If West Indian growers plant on soils requiring such heavy fertilization, they immediately lose their advantage of low production costs.

Heavy clay soils should be avoided because on such soils "gummosis" is serious. This disease should not be troublesome on medium soils that are well drained, if trees are budded 10 inches high on sour orange root stocks.

Shallow soils, underlain at 18 inches or less with an impervious subsoil or rock, are not adapted to successful citrus fruit production. Such soils do not permit maximum root development and are very liable to become water-logged. The presence in the soil of free water is injurious and will eventually result in the death of the trees through actual death of the feeding roots or through the development of mal di gomma (syn. collar rot, foot rot, root rot).

Therefore, a prospective planter should choose a medium soil, fertile, well-drained and at least 24 inches deep.

The question of annual rainfall must be considered. In the greater part of the West Indies, the rainfall is abundant and well distributed throughout the year. Areas having 50 inches of rain or less should be avoided. Grapefruit trees can bear good crops with 50 inches of rain per year if it is well distributed throughout the year. Under such conditions, however, the entomogenous fungi that attack the scale insects are unable to thrive and scale insects may cause severe damage to the trees. Spraying can be employed as a means of scale control but as the areas of higher rainfall are so abundant it would not seem wise to plant in districts where artificial means of scale control are necessary.

Further, in areas with an average rainfall of 50 inches, there will normally be years when the rainfall is considerably less, and in such years the trees will suffer from drought.

Rainfall of at least 75 inches is highly desirable and it should be well distributed throughout the year. During dry periods scale insects multiply rapidly and if these dry periods are of three or four months duration every year, scale may increase to such an extent as to become very injurious.

As to the safe maximum rainfall, little can be said. The writer saw grapefruit plantings in the interior highlands of Dominica under an annual rainfall of 200 to 250 inches and they were in excellent condition and bearing large quantities of clean fruit. As an example of successful grapefruit culture in a high rainfall area can be mentioned the planting of Messrs. Rossi and Rolle in Dominica. Their planting of several acres is at an elevation of 1,500 feet, with an annual rainfall of about 250 inches, yet the trees are in excellent condition in every respect.

With very heavy rainfall, however, grove costs are increased somewhat because of the necessity for providing an extensive system of surface drainage. The number of drains will naturally vary with the amount of rainfall and the slope of the land. In extreme cases, three or four main drains (about 18 inches wide by 18 inches deep) will be necessary per acre. Lateral drains (12 inches wide and 12 inches deep), feeding the main drains where possible, will be necessary between every second or third row. These drains must be cleaned whenever the land is cutlassed. The higher the rainfall, the more surface drains required ; the more surface drains, the higher the annual costs. Generally speaking, a rainfall of 75 inches to 100 inches will be found most satisfactory and economical.

The site for the planting should be chosen with due regard to the soil and rainfall conditions mentioned and factors of health conditions, social environment, transportation and slope of the land must also be considered. Proximity to a town may be deemed an advantage by some. In any case, proximity to planters having similar interests is a valuable asset to any individual. Social intercourse is one of the most important elements in one's life. Further, location in an area where there are citrus fruit growers leads to an exchange of thought and experience that can prove most valuable.

As grapefruit is a perishable article, any mechanical injury to it during transit from the grove to the consumer will result in decay. Good roads are a factor minimizing the injury that can take place from the grove to the point of export, hence location on a good road is a distinct asset. Trinidad is extremely fortunate in having an excellent road system.

A site for grapefruit planting that has a very steep slope should be avoided because of the fact that all grove operations, and particularly picking, must be carried out under difficulties. When picking is carried out under difficulties of any kind the handling of the fruit is very liable to be rough. Land with a steep slope will suffer from washing unless an extensive system of surface drains is provided. The prospective planter should choose land with a moderate slope. Flat land is very liable to be poorly drained but in the event that it is well drained, it is desirable.

A site that is exposed to strong winds should be protected by the planting of a suitable windbreak. In some of the islands " pois doux " has proved to be an excellent windbreak.

Planting the Grove.

Before the young grapefruit trees are planted, the land should be cleared of all natural vegetation. The cost of this clearing will vary from £3 an acre on land with little natural growth to about £8 on land that is heavily forested. The planting of young citrus fruit trees "under shade" is most undesirable as shade from cacao or other trees is injurious. The presence of non-citrus trees in the planting will cause upright growth of the young citrus trees that are shaded and delay their bearing period materially.

After clearing, it is necessary to fork up the actual spots where trees are to be planted. The digging up of a small area six feet or more in diameter is sufficient. Ploughing of the entire grove is probably unnecessary under West Indian conditions.

Surface drains are required in all areas subject to heavy rainfall. Drains should be made before the trees are planted and should be of such a number and depth as the rainfall, the character of the subsoil and the slope of the land indicate. No rule can be laid down in regard to the provision of surface drains as the problem is one peculiar to each individual grove.

The planting of a cover crop the year before planting and its subsequent ploughing under is not necessary as the soils in the areas under discussion are characterized by their high content of organic matter.

The square system of planting is the most satisfactory and is recommended. Contour planting is recommended in semi-arid countries where groves are set on a hillside, because by so planting, irrigation furrows can be run at an even, gentle gradient. Irrigation is not necessary in the West Indies, hence the square system of planting can be followed on flat and sloping land alike.

A planting distance of 30 feet by 30 feet will probably be found the most satisfactory. Even at this distance it will be found that in twenty or twenty-five years the trees will cover practically all of the available ground.

The use of "fillers," or trees set between those at thirty-foot intervals, is not recommended. Although the grower may fully intend to take the extra trees out when they begin to crowd the permanent trees, in actual practice he rarely ever does so at the time when it is necessary. If the fillers are bearing well, the

inclination is to leave them for a while longer; if they have not borne well, the tendency is to leave them a while longer and make them bear. Plant the trees 30 feet by 30 feet and do not attempt the use of fillers.

Various inter-crops can be grown successfully in a grove during the years before the trees come into production. An inter-crop should be an annual, the growth habit of which is not of such a nature as will interfere with the development of the trees. It should be planted in the centres of the rows only, leaving a clear space of at least 6 feet on each side of the trees. As the trees become older and larger, this space must be increased. At no time should the presence of an inter-crop be allowed to interfere with the trees. Care should be taken to see that, through the use of an inter-crop, the organic content of the soil is not diminished. It must always be remembered that the trees are the permanent and most valuable crop and their welfare must not be imperiled in any way. If the inter-crop is sufficiently profitable, cut the trees out and use the entire land for such a crop. At the end of four or five years, inter-cropping should be stopped.

The actual laying out of a grove is purely a mechanical operation and the procedure varies with the outline of the grove to be planted. Square or rectilinear plantings present no problems but irregular groves are somewhat more difficult. For the actual details of measurement, refer to books such as Wickson's "California Fruits," Coit's "Citrus Fruits," or Hume's "The Cultivation of Citrus Fruits."

A planting distance of 25 by 25 feet will give 70 trees to the acre; 30 by 30 feet gives 48 trees per acre.

Grapefruit trees can be planted at any time of the year provided no prolonged dry period is anticipated. Planting at the beginning of the dry period is not desirable because of the set-back that is given to the young trees during the dry weather. The root system has not yet become established and any drying out of the soil is injurious.

When the exact spot on which each tree is to be planted has been determined, the planting holes can be dug. It is not necessary to dig a large hole; the hole should be large enough to accommodate the roots of the nursery tree without cramping. The depth is

optional. If a hard subsoil is present it is well to extend the hole into it, placing rich top-soil in the bottom of the hole before planting the trees. Holes dug from 12 inches to 18 inches deep and from 12 inches to 18 inches in width are large enough.

No manure or organic matter should be placed in the hole. If a poor soil is being used and fertilizers are considered necessary, they should be strewn on the ground after the trees are planted. Manure or organic matter in the hole itself will result in subsequent sinking of the little trees.

Should a grower feel it necessary to plant on clay soil or on poorly drained soil, it is advisable that the trees be set on mounds about 6 feet square and 2 feet high or on ridges 6 feet wide

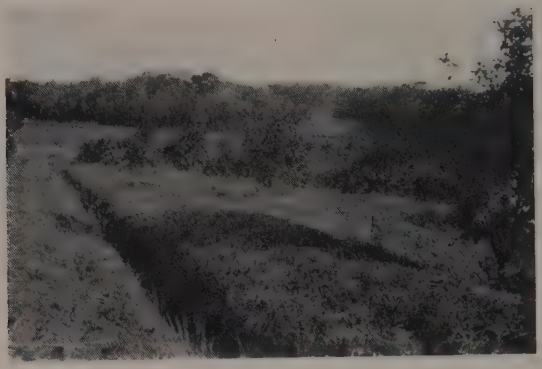

FIGURE 1.—A five year old grove in Trinidad, showing deep surface drains. The rainfall on this site averages 110 inches per year and the soil is heavy.

and 2 feet high running the length of each row. Such mounds or ridges should be made some months before the trees are planted in order that they may become compact and firm before the trees are set out.

When the planting holes have been dug, the nursery trees should be brought into the field, a few at a time as needed. It should be remembered that citrus trees do not live because of transplanting but *in spite* of it. They must be handled carefully and should not be allowed to dry out. The roots should be covered with wet sacking or grass. Any broken or injured roots should be cut away back of the injured point.

In placing the nursery tree in the planting hole, care should be taken to avoid any bending or cramping of the roots. When a tree is pushed into loose soil, the roots will bend, hence the trees should be *placed* in the holes.

One of the chief causes of gummosis is deep planting. The young nursery tree should be planted as high as possible. If the crown roots are just showing, the planting has been well done. Trees are rarely lost through excessively high planting; many are lost through deep planting.

As soon as the trees have been planted they should be given water unless the planting is carried out during very wet weather. Whitewashing of the trunks or the use of wrappings of grass or newspaper will prevent injury from sunburn and is recommended during the first year. It is quite possible that a grass or paper wrapping may furnish harbour and protection for some insect pest but the writer is not certain about this point. Advice should be sought from the local Department of Agriculture.

Bud Selection.

Growers realize fully that there are many kinds of grapefruit, each type possessing certain more or less marked characteristics. The present varieties, such as Marsh, Duncan, Walters, are each supposed to represent a type of grapefruit of certain characteristics. It is not fully realized, however, that our present varieties are each composed of *several* types of fruit, some good and some bad. For example, in the Marsh variety, which is supposed to be seedless, there can be found trees producing seeded fruits or pyriform fruits. Similar variations within the variety can be found with all varieties of citrus fruits. Variation in bearing ability is not as common as variation in physical characters of the tree or fruit but it does occur.

A grower who possesses a grove of Marsh grapefruit, for example, with a certain percentage of the trees differing from the desired standard type, is operating the grove under a handicap. Should a large proportion of the trees produce undesirable fruit (of poor flavour or shape) the grower is operating under a serious handicap. Even though a grove of a single variety should contain differing types and all be commercially good, uniformity of grading is impossible of achievement.

It is obvious, therefore, that a grower or nurseryman should select his parent trees with great care in order to be certain that they produce fruit of the desired type and in abundance. From a good parent tree can be propagated trees possessing the same characteristics ; from a poor parent tree will be propagated trees of the same poor characteristics. The asexually propagated descendents of a tree possess the same characteristics as the parent tree from which they are propagated.

In order that suitable parent trees for the purpose of propagation may be selected, the best trees in a mature grove should be studied and records should be kept of the quantity and quality of the fruit borne by each. In this way, after three or four years, the grower or nurseryman can determine the number and location of his best trees and use them for budwood.

The cutting of budwood from a grove, giving no attention to the character of the trees from which the buds are taken, should be severely condemned. In every grove are varying numbers of trees producing undesirable fruit ; the cutting of buds from such trees increases the number of the poor trees in existence and thereby lowers the quality and uniformity of the fruit produced by the country concerned, aside from the serious results to the individual who plants the poor trees.

Variation in quantity of fruit produced is very common but is usually due to variation in environmental factors. Inherent variation in yield ability does occur but is by no means as common as differences in the physical characteristics of the trees and fruit.

Select parent trees with the greatest care, being sure that they bear fruit in abundance and that the fruit is of the desired type in every respect.

Variation occurs not only between the trees of a given variety itself but in the physical make-up of a single tree. In other words, a single branch on a tree may bear fruit differing from the rest of the tree. Propagation of trees from such a branch will result in continuance of the variation (syn. bud sport, bud mutation, off-type). The grower or nurseryman should not only ascertain that his parent trees produce the desired fruit but that *all* of the fruit produced by them is uniformly of the desired type.

As bud variation or mutation occurs from time to time, it is unsafe to take budwood from young trees, even though they may have been budded from good parent trees. The chances are that a young tree so propagated will be true to the characters of its parent but the grower cannot afford to take any risk and should plant trees budded solely from bearing trees of a good type.

Through careful bud selection, the number of poor trees in a grove can be reduced to a minimum and variability of the ultimate product can be avoided.

Root Stock Selection.

Different species of root stocks have different effects on the scion (the portion of the tree above the bud union). Seedling plants of any given species are variable, differing in fruiting ability, type of fruit, leaf and branching characters or type of root development. These physical differences are very marked and it is to be expected that seedling root stocks will also differ in their effect on the scion.

Variation in size, shape, fruiting ability and nature of citrus trees is due to three factors: bud variation, environmental factors such as soil and moisture, and differing effects of the root stocks. The factor of permanent size difference is more clearly understood than any other, with a given stock, and is the one with which the grower is most concerned.

If sour orange stocks are grown to the age of a few months or more, it will be found that although they are of equal age, their size will vary. Some variation in size is undoubtedly due to unfavourable environment affecting certain plants, to insect injury, to a deformed root system or similar factors of a physical nature. Size differences of this nature cannot be expected to be permanent. However, there is a marked variation in size that is due to an inherent difference in rate of growth. Under similar physical conditions, one seedling will reach a size in a given time of 18 inches and another in the same time will grow only to 12 inches. Size differences of this nature are permanent; the stocks will always retain their *relative* size. The difference in rate of growth is transmitted to the scion and a tree budded on a slow growing stock will always be smaller, at the same age, than one budded on a more rapidly growing stock. The tree on the slow growing stock may be healthy in every respect and very productive but, because of its relatively smaller size, it can never

be as productive, under similar conditions, as the tree that was budded at the same time on the more rapidly growing stock.

Reference to Figs. 2 and 3 illustrates this point.

The trees are of the same age, are under similar environmental conditions and have been treated exactly the same throughout their life. Both are representative of approximately 10-acre groves, which are adjacent to each other. The best grove, composed of the large trees, was undoubtedly planted with large, vigorously-growing nursery trees, probably the first to be taken from a block of nursery trees. The first trees to be taken from such a block would naturally be the largest. The second grove was undoubtedly planted with nursery trees that were toward the last of those removed from a block. The

FIGURE 2.—Grove X, Strathmore, California.

FIGURE 3.—Grove Y, Strathmore, California.

last trees to be taken from such a block would naturally be those of a slower growing type that would take a few months longer to reach the desired size.

The difference in size of the original trees has remained and become more pronounced as the trees matured. The trees in Grove X cost 90c. each ; those in Grove Y were sold at 75c. in competition with the nursery from which the others came and were represented to be just as good as the others. Both groves are healthy and productive. The grove represented by Fig. 2 is more than twice as productive as the other because the trees are larger and can carry more fruit.

The application of this principle of permanent size differences in citrus trees is simple but of the greatest importance to the grove owner. When the young seedlings are transplanted from the seedbed to nursery rows, all relatively small ones and all with deformed roots should be destroyed. When the seedlings have reached budding size, only the largest should be budded and all small ones should be destroyed. The small ones will reach budding size if grown longer but they will never reach the same size as the larger ones because they are relatively slower growing.

When the budded trees are ready for sale or planting, all small ones should be destroyed. The number that will be eliminated at this stage will not be large, not over 5 per cent. to 10 per cent., if the culling in the preceding stages has been severe.

The result of this destruction of inferior plants will be the planting of trees of a very uniform and vigorous growth rate that will develop into large trees in the field. In the grove will be no under-sized, poorly productive trees that are inferior because of the character of the individual stock on which they are budded.

Nursery Practice—Purchase of Trees.

Upon the character of the nursery tree, depends to a large extent the character and productivity of the bearing tree. A good nursery tree can, of course, be planted under unsuitable conditions or managed poorly and hence give unsatisfactory results. A poor nursery tree cannot give good results even with suitable environment and treatment.

The best root stock for the West Indies, as far as one can say at present, is the Seville or sour orange. The sweet orange is susceptible to gummosis and hence is not as good as the sour orange in the countries under discussion. The rough lemon and the lime are also somewhat susceptible to root diseases and should not be used on a commercial scale. The grapefruit, the shaddock, or *Citrus hystrix* may prove satisfactory but evidence in support of this will not be forthcoming for many years. Commercial plantings should be confined to the sour orange root stock and other stocks should be used purely in an experimental way.

If several growers were to plant a dozen trees on several stocks, purely for trial, much practical information would be gained as to the good and bad points of stocks other than the sour orange.

The seedbed should be well drained and of medium to light soil. Heavy soil may restrict root development and favours the development of " damping-off." The seedbed can be made to cover any area desired but for convenience in weeding and caring for the little seedlings it is well to lay it out in belts or strips about 4 feet wide. The length of these beds is immaterial. It is advisable, under the heavy rainfall conditions in the West Indies, to have the beds raised about 9 to 12 inches. Between each four-foot bed should be left a path 18 inches to 24 inches wide. The soil should be dug up to a depth of at least 12 inches and preferably 18 inches. It should be finely pulverized and levelled.

Seed should be obtained from healthy, vigorous, well-grown trees, preferably old ones, and if possible should all be obtained from one tree for the sake of uniformity. Seedlings from different trees probably have different growth rates and may differ in other characteristics as well. The seed should be planted as soon as possible after its removal from the fruit as any drying out before planting will favour the development of crooked roots, the most pronounced type of which is termed " bench root." The fruit can be cut with a sharp knife, cutting only part way through it in order that none of the seeds may be injured. The two halves are twisted apart and the seeds worked out with the fingers into a container. Several washings with water will remove the rag adhering to the seed and facilitate sowing. Should the seed become dry, through unavoidable circumstances, it should be soaked for 24 hours before planting.

The seed can be broadcast in the seedbeds or sown in rows about 6 inches apart, the seed being set 1 inch apart in the rows. A strip of narrow wood pressed lightly into the prepared seed bed will form a very shallow furrow in which the seeds can be placed. The seeds should have some soil raked or scraped over them and then about three-quarters of an inch of sand should be sifted over the entire seedbed.

A fungous disease, " damping-off," is frequently troublesome when the seedlings are young. It attacks the little seedlings at the surface of the ground and the frail stems collapse at the point of attack and the seedling dies. Its progress through a seedbed can be very rapid, a matter in many cases of one or two days. It can usually be avoided by providing adequate drainage (as with the raised seedbed), by allowing the surface of the soil to dry out quickly (hence

the sand mentioned above and the advisability of applying water in the mornings rather than in the afternoons), by avoiding heavy soils and by keeping the soil reasonably free from organic matter, and by an occasional spraying with Bordeaux mixture. If the disease is troublesome, seek the advice of the local Department of Agriculture.

The seedbed should be kept fairly moist but excessive watering is harmful. Facilities for irrigation or watering should be provided as the dry period of the year may affect the small seedlings adversely. The writer saw several nurseries in Trinidad, during a period of dry weather, that were suffering severely because of a lack of water. With small nurseries, ordinary sprinkling is satisfactory, but on a large scale, furrows should be made between each row and water run in them when necessary. The interval between waterings varies with the texture of the soil, wind, temperature, frequency and quantity of rainfall, and other factors, hence no set period can be mentioned.

The seedbed should be kept free from weeds and insect pests.

When the seedlings are about 6 inches to 8 inches high they can be transplanted to the nursery. The seedbed should be thoroughly soaked and each row of seedlings should be forked up, thus allowing them to be removed without injury to the roots. It is of the utmost importance that all small, weak, diseased seedlings and those with deformed roots should be destroyed. Probably 50 per cent. of the seedlings will fall within this category and with possible additional losses from "damping-off," about treble the required number of seedlings should be planted. The tiny seedlings are of little value as individuals and heavy culling of them at this early stage is inexpensive, although of great importance.

The nursery site should be of medium to light soil, at least 18 inches deep, well drained and level. It should not be exposed to strong winds. It should be cultivated deeply, well tilled and free from weeds.

The seedlings are taken from the seedbed and the tops are trimmed and the tap root is cut back for a few inches. Whether the cutting back of the tops for two or three inches in necessary in the West Indies or not, the writer is unable to say. It is suggested that when a large number of seedlings are being shifted, half be cut back and half be untouched and the results compared. After removal from the seedbed, the seedlings should be placed immediately in wet

sacking to prevent any drying out. They are planted in nursery rows about 4 feet apart, being set 12 inches to 15 inches apart in the rows. The soil should be moist before the seedlings are planted and should be given an additional watering immediately after they are planted. This is best done by running water in furrows along each row and is required only when the soil is not sufficiently moist from the natural rainfall. The planting is done with a dibble or trowel and great care should be taken to see that the seedlings are not pushed into the ground in such a way as to cause any bending of the tap root. A bend caused at this time causes permanent deformation of the root system.

The nursery should be kept free from weeds, insect pests and diseases. Should verrucosis (scab) develop, it can be controlled by spraying with Bordeaux, 4–4–50. The plants should be watered when necessary.

During the period when the stocks are growing to budding size, all side shoots should be rubbed off whenever they appear. This ensures a straight stem and hastens the time when budding can be done.

Budding can be done at any time the bark slips, when the stocks have reached a diameter of three-eighths to one-half inch at the height at which the bud is to be inserted. Under the conditions of heavy rainfall and heavy soils so typical of the West Indies as a whole, and the resulting danger from collar rot, budding should be done at least 10 inches from the ground. This is higher than is practised in other countries but it must be remembered that in California, Florida or South Africa the rainfall is much lower and the soils are generally lighter than in the West Indies. High budding greatly reduces the danger from collar rot, not only by keeping the susceptible grapefruit wood away from the ground level but also by keeping the bud union at a safe height. The bud union itself is a weak point and particularly susceptible to gummosis diseases.

Shield or T-budding, using the inverted T, is the most satisfactory. The budwood should be young and plump. Old wood contains many dormant buds which do not grow readily ; young, angular wood is difficult to handle and is deficient in stored food reserves.

As previously discussed, budwood should only be cut from trees known to produce the desired type of fruit in abundance and only from such trees as show the least tendency toward single limb mutations. Budwood can be kept for some weeks if the ends are waxed and it is wrapped in damp moss but it is better to use freshly cut wood.

At the time of budding, all small trees should be destroyed.

In the stock, at a height of 10 inches, an inverted T-cut is made. The bud is cut from the bud stick, about three-quarters of an inch to one inch long, and is inserted in this cut, under the bark. The bud union is then wrapped with waxed cloth. Raffia wraps are used in semi-arid countries but whether or not they would be as satisfactory in the West Indies, the writer is unable to say. It is possible that waxed cloth will be found better than raffia because of the high rainfall and humidity.

Under the very favourable growing conditions of the West Indies, the newly inserted bud will probably start into growth with no further attention beyond a loosening of the wrappings after the first ten days. Should the bud be green and healthy after three weeks and yet remain dormant, the stock should be cut half-way through about 4 inches above the bud and bent over until the top rests on the ground. If this is followed with all of the trees in the nursery, each top in a row should be " lopped " in the same direction. It is quite possible that this " lopping " will hasten the development of the bud even when it grows out without forcing, as the semi-detached top of the tree furnishes much elaborated plant food to the roots.

When the bud has grown out about 9 inches, the stock can be cut away about an inch from the bud union. It is quite possible that it may be advantageous to leave the lopped top for three or four months as a source of plant food supply. While this practice is followed in some other countries, the writer hesitates to recommend it for the West Indies but suggests it for trial.

Should the top be removed entirely, the stub should be cut away when the bud has grown out about 18 inches. The cut should be made slanting in order that it may heal over quickly and soon. It should be painted with Bordeaux paste, white-lead paint, an asphaltum paint, or other wood preservative.

The staking of nursery trees leads to the production of a straighter tree than would otherwise be the case. Further, the tree can be headed at the desired height and all of the trees can be headed at a uniform height. A flat stake about 38 inches long and 1 inch wide should be driven into the ground beside each tree soon after the bud begins its growth and the bud shoot should be tied to this stake from time to time as it continues its growth. The ties should be made frequently in order that no outward bending of the little trunk may take place between the ties. Raffia is excellent material for this work. If the base of each stake is dipped in tar before it is driven into the ground, its life will be materially lengthened.

FIGURE 4.—A nursery in Florida, illustrating the method of training the young trees.

When the tree reaches about 36 inches in height it is headed 30 to 32 inches from the ground. This removal of the top causes several shoots to be thrown out, of which four to six should be left and the balance removed. These main scaffold branches should be spaced for 6 to 12 inches vertically on the trunk; in other words, they should not arise from a small space, as when this occurs a weak head is formed. The scaffolds should not arise from one side of the trunk alone but should be well distributed *around* the trunk. No scaffold branches should be allowed to develop under about 20 inches from the ground.

When the trees are large enough to be moved from the nursery, normally in 9 to 12 months, they should be irrigated well the day

before they are to be moved, unless soaking rains have recently fallen and the ground is in a very moist condition. A trench dug or ploughed along one side of each row greatly facilitates the digging out of the trees.

Trees that are to be transported any distance should have the scaffold branches cut back to 6 inches. It is probably not necessary to remove the leaves, as is frequently done in drier countries. If the trees are to be planted within a few minutes after removal from the nursery, the cutting back of the scaffolds may be omitted.

At the time of transplanting, all small, weak trees should be discarded as they are inferior to the well-grown, vigorous trees and will always remain so. All trees with deformed roots should also be destroyed. Heavy culling in the seedbed will greatly reduce the percentage of inferior trees found at this stage.

A nursery tree of the best type and grown in the best manner cannot be produced for less than 2*s*. When it is considered that the net value of the crop produced annually by each tree is from 10*s*. upward, it can be seen that a saving of a few pence in the original cost of the tree is negligible, yet a saving of a small sum in the beginning may mean great losses later. Further, considering the capital outlay in land and its preparation for planting, the annual outlay for labour and the care of the young grove, and several years of waiting for the trees to reach bearing age, it seems very absurd that any planter should think of saving a shilling a tree in its first cost and pay little attention to the inherent quality of the tree, when by so doing his large investment in time and money may be imperilled. Planters should insist on getting the best nursery trees that it is possible to produce ; the cost of such trees, within reason, is entirely immaterial.

Whether the prospective planter should grow his own trees or purchase them from a nurseryman is largely an individual question. A beginner with no previous experience in citrus fruit growing should purchase his trees from a reliable nurseryman. A man with an established grove who wishes to extend his plantings may care to grow his own trees. It is a fallacy to presume that a few hundred trees can be grown more cheaply than they can be purchased. The nurseryman knows his business (in some few cases at least) and through specialized and large-scale work can produce good trees just as cheaply and usually more cheaply than the small grower can.

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When trees are to be purchased from a nurseryman, the grower should make certain that the nurseryman is using budwood taken only from parent trees of known character and that he is following the most careful stock selection, according to the lines mentioned heretofore. Trees that are only one year from bud should be specified in placing any order. Such trees stand transplanting better than older ones, but the chief point in favour of the young tree is : if the tree is large enough for sale in 9 to 12 months from the time of budding, it is fairly good evidence that it has been budded on a rapidly growing stock and as such is an inherently vigorous tree.

The planter should insist that the trees be supplied " bare root " in order that any with deformed roots may be detected and rejected.

Care of the Young Grove.

Young trees should be given continual attention. An inspection of each tree (by the planter himself and not by unskilled labourers) should be made at least every two months. Any undesirable condition can thus be found in its early stages when remedial measures are the easiest and most economical to apply.

Weeds and " bush " should be cut down whenever necessary with a machete (cutlass), the cut material being allowed to remain where it falls. Such growth should never be allowed to become so rank as to interfere with the growth and development of the young trees. At all times an area extending 6 feet on each side of each tree should be kept clean and in this area vegetation should *never* be allowed to develop to a height exceeding 2 feet. Clean cultivation in this area through an occasional light forking may be best but there is no evidence in support of this point. Should such an area be kept entirely clean, some of the cut weed growth from the centres of the rows should be strewn in this clean area when it is cut.

For the first few years until the trees come into good bearing, the principal care of the grove will consist of controlling weed growth, keeping a close watch for depredations of insect pests and giving an occasional light pruning. In carrying out the latter operation, the object should be to remove any branches that arise from undesirable positions. Should suckers arise, they should be removed, unless they can be utilized to make a better balanced tree. When two branches cross, one should be removed, in whole or in part. No branches should be cut back in such a way as to leave a stub.

If a branch is not to be removed entirely, it should be cut back to a lateral. If a branch is to be cut away entirely, make a clean and smooth cut that will heal over readily. Any cut over an inch across should be painted over with a wood preservative. If a tree is properly trained from the time it is planted, cuts of this size will rarely ever have to be made. In pruning grapefruit trees, a good maxim to follow is : when in doubt, leave it.

Should any scale insects attack the young trees they should be thoroughly sprayed with one of the usual sprays used for such pests, such as whale oil and soap, resin wash, soap and water, or the commercially prepared insecticides. The orange dog, a caterpillar that consumes young orange and grapefruit leaves, is best controlled by hand picking.

FIGURE 5.—A grapefruit tree recently planted. It had no training in the nursery and on planting in the field should have been staked. Compare with the trees shown in Fig. 4.

For the control of the " parasol ant " (or the weevy ant of British Honduras) or the black stingless bee (*Melipona silvestriana*, probably the same as the " drunken Bayman " of British Honduras) the writer is unable to make any suggestion beyond searching for and destroying the nests, by mechanical means or through the use of cyanide.

Under average soil and moisture conditions in Trinidad, Dominica, St. Lucia or Grenada, the use of fertilizers in young groves is not necessary. As long as the trees are healthy and vigorous, fertilization need not be considered.

Fertilization.

In California, Palestine, Florida, South Africa and Spain, the item of fertilization forms a considerable portion of the annual grove expenditure. In Palestine, for example, the average cost per acre per year is £17. In Florida commercial fertilizers are used in large quantities, from 60 to 90 pounds per tree per year. On the rich soils so plentiful through the four islands under discussion, and in British Honduras as well, the required outlay for fertilizers is little or nothing. The subject of soil fertility is too long for detailed treatment in this paper and in regard to the West Indies it

Figure 6.—A young grapefruit tree that was not trained and formed a head too low. Compare with Fig. 7.

is one on which the writer can only give conclusions based on comparatively short observations. Experimental work in California is of no value in the West Indies because of widely differing climatic and soil conditions between the two areas. In considering the ordinary fertilizing practice in Florida, planters should realize that the soils of Florida are practically pure sand and are very deficient in available plant food. The West Indian soils, for the most part, are heavy, contain a great abundance of organic matter and are extremely fertile. Observations in South Africa, Spain or Palestine cannot be used as a guide in the West Indies because of marked differences in climate and soils.

While it is evident that fertilization of the soil is essential to heavy fruit production and good tree health, it is by no means clear as to the kinds or quantities of fertilizers that should be added to the soil in order to get the best results, nor is it evident at what stage in the life of the grove fertilization should be commenced. The question varies with the climate and soil and is one that is frequently peculiar to the individual grove. The problem with the rich soils of the West Indies is not one of building up soil fertility but rather one of maintaining the fertility already present. Soil fertility, under tropical conditions, is directly associated with the organic content of the soil, hence any factor that leads to the

FIGURE 7.—A young grapefruit tree with a good head. Compare with Fig. 6. Photo taken in Trinidad.

establishment or maintenance of an abundant supply of organic matter in the soil, will presumably establish or maintain an abundance of available plant food. Until further evidence is available, planters should consider their soil fertility problem in this light.

The presence of a large quantity of organic matter is advantageous because through its decomposition, additional plant food is made available through the action of weak acids on the adjacent soil particles; it is greatly retentive of moisture, yet a soil that is rich

in organic matter is usually better drained and aerated and suffers less from surface erosion than other soils; its presence prevents packing and hardening of the soil.

From observations in the islands, in British Honduras and in Jamaica, the writer is able to recommend the practice known in the latter country as "bush mulching." It consists of cutlassing the weed growth in the grove from time to time during the year and letting the cut grass remain on the surface of the soil between the trees. In addition, grass and small bush from adjacent land may be cut and strewn through the grove in order to supplement the organic matter produced on the land itself. This practice can be carried out very economically as the only expenditure is for labour.

FIGURE 8.—Twelve year old grapefruit in British Honduras.

Numerous bearing groves are to be found in the West Indies, British Honduras and Jamaica that have had no soil treatment beyond "bush mulching" and where the mulching has been carried out thoroughly the groves are in good condition and are bearing well.

One interesting example can be given showing the effect of mulching upon the recovery of an abandoned grove. In a certain area in Dominica, a grove was planted some ten years ago and soon afterward was allowed to revert to bush, upon the abandonment of the estate due to the ravages of the wither-tip of the lime. Three years ago a portion of the grove was cleared of bush, surface drains were dug and an abundant quantity of organic matter was strewn

through the grove, supplemented with a small quantity of cattle manure. The soil was not cultivated, nor was any fertilizer used beyond the organic matter mentioned. Each year the grass was cutlassed whenever necessary. When first cleared from bush the grapefruit trees were nearly dead, were tall and spindly with a few leaves at the ends of the branches. They have since made a remarkable recovery, have filled out to their normal shape and are healthy and vigorous in appearance. The crop from these trees for the season 1927–28, three years after removing the bush, averaged 500 fruits per tree and was sold on the London market at very remunerative prices.

Mulching alone may prove to be insufficient over a long period of time and it certainly cannot be used to the exclusion of everything else on poor soils. It is quite possible that it will be found advisable to supplement mulching with the use of manure or commercial fertilizers but information on this point will not be forthcoming for some years.

Commercial fertilizers should not be used unless the planter is satisfied that their use is necessary. Statements of fertilizer dealers should not form the basis for the fertilizer practice to be adopted, nor should consideration be given to soil analyses. If the trees are healthy and vigorous and bearing well, they are in no immediate need of fertilizers. If the annual growth is unsatisfactory, if production declines or if the foliage becomes pale in colour, fertilization may be the solution of the trouble. Before acting on this conclusion, however, the planter should explore other factors such as insect injury or disease and particularly drainage. Waterlogging of the soil is highly injurious and may readily occur under conditions of heavy rainfall. Fertilizers are expensive and should only be used as a last resort.

One frequently hears of the injurious results in Florida occurring when manure is used in the citrus groves. Planters in the West Indies should not assume that injurious effects will follow their use of manure. Because of the sandy nature of the soils of Florida, the nitrogen in the manure becomes available very rapidly and probably results in over-stimulation of the trees. Manure added to the heavier West Indian soils would not react in the same way.

The planting of a leguminous crop between the trees, as is practised to some extent in Dominica, may prove more beneficial than keeping the ordinary weed growth. An excellent legume for interplanting is the *Tephrosia candida,* which makes very rank, succulent growth, thus supplying a large quantity of mulching material. In the event that the planter wishes to augment the supply of organic matter produced within the limits of the grove itself, it is suggested that plantings of *Tephrosia* be established near the grove. It can be cut back to 6 inches from the ground three or four times a year and placed on the ground between the trees.

Although continual mulching for three or four years has proved injurious in California, there is ample evidence that it can be carried out for ten or fifteen years under tropical conditions with beneficial results.

Cultivation.

It is generally accepted by an increasing number of experimental workers that the sole objects of cultivation are (1), the preparation of a seedbed, as for sowing a green manuring crop ; (2), the incorporation of fertilizers ; (3), the preparation of a soil to receive moisture ; (4), the destruction of weeds. Cultivation of the soil probably does not conserve moisture except in so far as it destroys weeds.

When cultivation is carried out with one or more of the above-mentioned objects in view it can be considered as being beneficial, otherwise it is unnecessary. Consideration of these four objects in the light of conditions existing in the citrus fruit plantings of the tropical West Indies shows that cultivation is probably unnecessary.

For the establishment of a green manuring crop such as *Tephrosia,* a very shallow forking of the soil is sufficient.

The second point, the incorporation of fertilizers, does not apply as the mulching recommended is purely a surface operation. Should commercial fertilizers ever be used, their distribution on the surface of the soil would be satisfactory. The rainfall is sufficient to carry them down to the root system which, as a matter of fact, is very close to the surface.

The third point, preparation of a soil to receive moisture, is not applicable except in the nursery, as irrigation of a grove is not required. A clean cultivated grove would suffer severely from erosion, while a grove under grass or a cover crop would not be affected by washing caused by heavy rains.

The fourth point, destruction of weeds, is applicable in the case of the young grove and in the nursery. It is probably advisable to keep an area clean on each side of the young trees. With bearing trees, of the desired drooping habit of growth (*see* Fig. 10), weed growth near the trunk is partially controlled by the shading effect of the branches. Conservation of moisture through the destruction of weeds is not necessary because the annual rainfall is ample for the needs of the trees and the weeds and is well distributed throughout the year.

Under the conditions in the areas recommended for grapefruit planting, the root system of the trees will be found very close to the surface of the soil, the bulk of the roots being in the upper 12 inches of soil. The upper 6 inches contain a large quantity of fibrous feeding roots and as such is the case cultivation could easily do a great deal of harm to the trees.

Cultivation of mature grapefruit or orange plantings in the West Indies in general is not recommended as no object can be gained by cultivation under the climatic and soil conditions in question. This statement must not be interpreted to mean that neglect of the grove is recommended. It is of the utmost importance that the growth of the natural vegetation, or green manuring crop used in substitution thereof, should be kept under proper control. *The weed growth must be cut regularly and never be allowed to interfere with the development of the trees.* Further, great care must be taken to keep *all* weed growth at least a foot away from the base of the trunk, regardless of the age of the trees. Weed growth close around the trunk is an important factor in the development of crown root diseases, the most common of which is collar rot.

Diseases.

Of diseases that affect the trees themselves, the trouble known as " gummosis " is by far the most serious. There are no data available to show the exact cause or causes of the forms of gummosis occurring in the West Indies and British Honduras. Gummosis of the limbs themselves is not common but the crown root type, or collar rot, occurs fairly frequently. Other forms of root rots may affect the sour orange root but on this point there is no information.

The sour orange root stock is extremely resistant to disease, hence its use is recommended to the commercial exclusion of all other stocks. It is virtually immune to collar rot and probably immune to the " red root " so serious in Dominica with seedling West Indian limes.

Collar rot is a fungous disease attacking certain species of citrus plants at the base of the trunk and extending downward on the crown roots. The disease does not extend upward beyond 2 or 3 feet. Cracks form in the bark and the bark and cambium layer are eventually killed. The dead bark usually strips off from the trunk but may shrivel or contract and give the affected area a sunken appearance. The trunk may be girdled in time and the death of the tree result. Gum may or may not form, depending largely on certain external conditions. (*See* Fig. 9.)

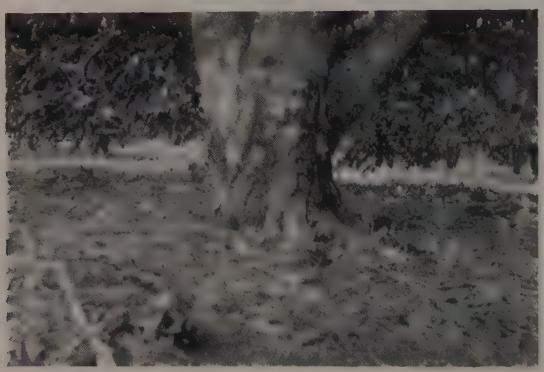

FIGURE 9.—Collar rot on seedling or low budded grapefruit in British Honduras.

The conditions leading to the development of collar rot are (1), the presence of water or moist soil in contact with the trunk over a sufficiently long period of time ; (2), low planting, low budding or the accumulation of soil around the trunk ; (3), a susceptible root stock ; (4), bark injuries, particularly near the ground, such as would result from careless use of a cutlass ; (5), favourable soil and air temperatures.

As previously mentioned, trees should be planted as high as possible, regardless of the height at which they stood in the nursery.

The continual presence of thick weed growth around the base of the trunk should be avoided as it keeps the bark moist and tender and hence very susceptible to disease invasion. An accumulation of soil around the base of the trunk is very injurious. The crown roots should always be kept slightly exposed as no harm will be done and one cause of collar rot will have been eliminated.

Budding should be done at a height of 10 inches from the ground in order that the susceptible grapefruit or sweet orange wood may be kept a safe distance from the ground. The bud union itself is particularly susceptible as a point of infection and should be kept at least 10 inches from the ground.

The treatment of collar rot lies chiefly in its prevention through following the points given. Should the trouble develop, however, all diseased bark and tissue should be carefully scraped away and all soil should be removed from the base of the tree in such a manner as to leave the crown roots exposed for at least a foot. Soil below the crown roots should be removed as well as that above them. After scraping, the crown roots and the scraped area should be painted with a disinfectant such as Bordeaux paste or tar paint.

The recovery of trees that have become badly affected with collar rot can be greatly accelerated by "in-arching" with small sour orange seedlings. Trees that have been completely girdled can be restored to vigour in this way. In-arching is a very simple operation that can be done successfully by all growers. Seedling sour oranges 24 inches to 30 inches high are planted about a foot away from the trunk of the tree to be treated. Strong, rapidly growing seedlings should be chosen for this purpose. Three or four should be set around a mature tree. When these seedlings reach a diameter of three-eighths to one-half inch at the height at which it is proposed to make the in-arch, the work can be done. The point of in-arching should be several inches above the diseased area and in no case should it be under 10 inches from the ground.

The steps to be followed are :—

(1) Cut off the top of the seedling at the desired point, making a sloping cut two or three inches long, the cut surface facing the large trunk to be treated.

(2) The bark of the large tree should be cleaned and if too thick should be scraped down somewhat at the point of in-arch. The seedling should have one or two small holes drilled or punched in the sloping cut at right angles to it.

(3) The cut end of the seedling is inserted in the cut in the bark of the diseased tree, a three-quarter inch thin nail being carefully driven in each punched hole and the point of in-arching is then covered with warm grafting wax. The object of using the small nails is to keep the seedling tree in firm contact with the trunk.

It is not essential that the seedling trees be planted around the diseased trees before in-arching. Through the use of seedlings of a sufficient size, the in-arching and planting can be done at the same time. The operation should be done at a time when the trees are in a rapidly growing condition in order that the bark may slip easily. The trunks of mature trees will frequently have a ridged or fluted surface. In such cases, the in-arch should always be made on a ridge as this area is more rapidly growing than the adjacent depression.

One of the most important steps in the control of collar rot or any form of tree disease is a semi-annual inspection of each tree in order that the trouble may be found in its early stages, at which time it is not difficult to treat successfully.

Insect Pests.

As the writer is not an entomologist, he is unable to give definite recommendations for the control of insect pests under tropical conditions. The citrus insect problem in the West Indies is quite different from that of semi-arid countries.

Fumigation for the control of scale insects as practised in South Africa and California is out of the question because of climatic conditions. In areas of continually high humidity, fumigation is not a commercial success. Spraying for scale control may occasionally become necessary in the drier areas but as a rule the scale insects are well controlled through the action of entomogenous fungi. In dry areas or in dry seasons, the work of these fungi is checked and scale insects increase in numbers.

Should rust mite injury be serious in any section, spraying with lime-sulphur or dusting with sulphur containing about 8 per cent. hydrated lime will give control. When rust mite injury is expected, a

spraying or dusting should be given when the fruit has reached an average diameter of 1 inch. Further treatment is given whenever rust mites become numerous.

For details of miscellaneous insect pests and the recommended manner of treatment, growers should consult their local Department of Agriculture.

Varieties.

A country that produces a large quantity of fruit of a small number of varieties is able to approach uniformity of its product far more than a country that grows many varieties. Uniformity of a given product is of great value in the large markets and this point is so evident that it need not be discussed here.

The growing of seedling trees should be discontinued and fruit from existing seedling groves should not be shipped unless it is exceptionally good. Fortunately, British Honduras and Jamaica are the only areas where the seedling grapefruit has been planted in groves.

It is recommended that the West Indies should plant the Marsh and Duncan grapefruit. Both varieties are entirely satisfactory and growers should limit their plantings to these two varieties to the exclusion of others. From a marketing viewpoint, it is extremely desirable that there should be uniformity of varieties between the various islands. Additional varieties will probably be found to be suitable but unless they are *better* than the Duncan and Marsh, it would be better, for the sake of uniformity, not to plant them on a large scale.

Tree Records.

The unit of production in citrus fruit growing should be the individual tree. The total production of fruit per acre is not a true indication of conditions in the grove as the bulk of the fruit may be coming from a few trees only. For example, a given acre of land on which are planted 50 grapefruit trees may produce 300 cases of fruit, an average of 6 cases per tree. A study of such a planting would probably reveal the fact that the bulk of the fruit was being produced by 50 per cent. or less of the total number of trees. The unproductive trees are being maintained at a loss and if they could be made more productive, the returns to the planter would be greatly increased. A grove as a whole may produce a satisfactory crop but if even a quarter of the trees are not bearing well, the production is not as high as it should be.

Available space does not permit a full discussion of the uses and manner of keeping tree records.* Briefly speaking, each tree is given a numerical identity. Each row of trees is numbered and each tree in each row is numbered. Thus, the tenth tree in the fifth row is Tree 10, Row 5 ; the tenth tree in the twelfth row is Tree 10, Row 12. The row and tree number can be painted on the trunk of each tree, one above the other, using white lead paint.

Shortly before the fruit is picked, an estimate is made of the fruit on each tree and the estimate is recorded on a suitable form made for this purpose. The most simple method of estimation, one that eliminates variation in quantity of yield due to climatic factors, is to class the production of each tree as being very good, good, medium, poor or very poor. Each of these classes is given a representing number : 5, very good ; 4, good ; 3, medium ; 2, poor ; 1, very poor. Only the number is recorded on the estimate production chart.

When records have been kept for four years, the planter can classify his trees as being profitable or unprofitable and take steps accordingly.

When a tree is found to bear poor crops over a period of four years, the unproductiveness is due to inherent disability, unfavourable stock reaction or to unfavourable environmental conditions. If the tree is not capable of bearing well, it should be removed or top-worked. Top-working of a tree that is a poor bearer because of an abnormal stock reaction will not alter the condition, hence such a tree must be removed entirely and replaced with a new one. If the failure to bear well is due to some unfavourable factor of environment, the obvious remedy is to change this factor. As a general rule, low production is due to poor environment, either natural or cultural.

A tree or group of trees may have been planted on shallow soil, poorly drained soil, sandy soil ; a tree with a deformed root system may have been planted by error ; some trees may have collar rot ; the soil in a particular spot may be lacking in fertility, etc.

Factors causing low production can be studied most successfully when a map of the grove is made, on which small squares represent each tree. After a period of four years, those trees that have borne good or very good crops (classes 4 and 5) can be considered as being

* Copies of Transvaal University College Bulletin 8, " Citrus Tree Records and Their Uses," can be secured upon application to the Registrar, Transvaal University College, Pretoria, South Africa.

profitable ; those that produce medium crops (class 3) are neither profitable nor unprofitable, they give no returns above expenses ; those that produce poor or very poor crops (classes 1 and 2) are certainly unprofitable.

The best results from this grouping of trees is to be found in filling in the above-mentioned map in three colours, green representing classes 4 and 5, the profitable trees ; black representing class 3, the self-supporting trees ; and red representing classes 1 and 2, the unprofitable trees. Each square on the map represents one tree and each square is coloured according to the productiveness of the tree it represents.

FIGURE 10.—A mature grapefruit tree of good size and shape. It is probably about 20 years old. Photo taken in Florida.

We will presume that the distribution chart shows a group of trees in one part of the grove that are unproductive. It is not likely that the unproductiveness in such a case is due to inherent or to stock factors, as where such occurs the poor trees are usually scattered through a grove with no regularity or grouping. The unproductiveness of this group of trees is therefore probably due to one or more environmental factors, examples of which have already been given. The particular factors can be determined and remedial measures taken as warranted.

Through the use of individual tree production records, the efficiency of a grove can be materially increased and to an interested planter a study of this nature can not only be very profitable but extremely absorbing.

Picking and Packing Operations—Fruit Decay.

The marketing of citrus fruits is as important as the actual production of the fruit, as the production itself is carried out in vain unless the fruit can be marketed successfully. The object of production is the successful and profitable marketing of the article produced. The fruit must be picked, packed and shipped under such conditions as will ensure its arrival in the markets in a condition that will make it attractive and satisfactory to the trade.

The chief causes of decay in grapefruit under tropical conditions in the West Indies are stem-end rot (*Diplodia* spp. and *Phomopsis* spp.) and the blue-contact and green moulds (*Penicillium italicum and P. digitatum,* respectively). The latter two are commonly grouped together under the general term " blue mould."

Where losses in transit from stem-end rot are serious, it is suggested that an attempt at control be made through carrying out the following points :—

(1) Keep the trees in a vigorous, healthy condition as fruit from such trees is more resistant to the attack of the fungus causing the disease. Fruit from seedling grapefruit trees, which are usually unthrifty and full of dead wood, will probably be found to suffer much more from stem-end rot than fruit from thrifty, budded trees.

(2) Dead wood should be removed from trees in groves in which the fruit is subject to the disease.

(3) When the disease is very troublesome, spray the young fruit once or twice with 3–3–50 Bordeaux mixture.

Full details regarding Phomopsis stem-end rot, blue-contact and green mould, collar rot and other citrus diseases can be found in Fawcett and Lee's " Citrus Diseases and Their Control," McGraw-Hill Book Company.

Blue-contact and green moulds usually attack citrus fruits only at a point of injury. If fruit is shipped that is free from mechanical injuries, the loss from decay in transit due to these fungi will be reduced to a minimum.

Prevention of mechanical injuries to the fruit in the picking, packing and transport operations is not difficult to secure. Decay in transit of 10 per cent. or more is unnecessary and forms a serious handicap to the grower. Not only does the shipper lose financially

but the particular brand of fruit and its country of origin gain an unenviable reputation. With increasing competition in the markets, a grower or country whose fruit is known to be free from excessive decay, possesses a great advantage over other growers or areas whose fruit may or may not arrive in sound condition.

Pickers should be taught the importance of extreme care in handling the fruit. Pickers should be equipped with gloves in order that finger nail scratches may be avoided.

Fruit should never be dropped or bruised in any way at any stage of the handling. Dropped fruit should be left on the ground or sold locally.

Clippers should be used of a design that will not cause injury to the fruit.

The fruit should be placed in suitable containers and these should always be kept free from projecting points or splinters. The containers should be shaken out just before fruit is placed in them in order that any foreign material such as twigs or small grains of sand may be removed.

Everyone handling the fruit should be taught that it is a highly perishable article and must be handled as such.

The stem should be cut flush with the button but should not be cut so close as to injure the button. No projecting stems should be left, even though only a thirty-second of an inch long, as fruit coming in contact with such a projection will be injured.

Fruit should never be piled over 18 inches deep. When fruit is piled deeply, the pressure on the lower fruit is sufficient to cause bruising ; any grit or twigs at the bottom of the pile will be pressed into fruits on the lower layer ; any projecting stems will be pressed into the fruit above.

No fruit should be picked when the trees are wet from rain or dew and no fruit should be picked for two or three days (in extreme cases, more) following a long period of rain.

Fruit should never be exposed for more than an hour to the sun.

Fruit should be wilted or cured for as long a period as may seem advisable before it is packed. This period will vary with weather conditions, storage facilities, and with the maturity of the fruit. From five to ten days is desirable in most cases.

An abundance of grapefruit of excellent quality is shipped to the English and Canadian markets. Growers should not ship any fruit that is not fully mature. In countries that have no legislation setting the minimum degree of maturity, the tendency is for some growers to ship immature fruit. If the ever-expanding grapefruit market is to continue its present rate of expansion, immature fruit must not be shipped.

FIGURE 11.—A well-grown, five-year Marsh grapefruit, showing a good type of growth. Photo taken in Florida.

Grapefruit can be held on the trees for some weeks after picking maturity has been reached. It can also be held for several weeks in common storage. By using a combination of storage on the tree, followed by storage in a cool, well-ventilated room or basement, the marketing season can be materially lengthened.

If handled carefully, grapefruit can be transported for a considerable distance before it is packed. There is no need, in any of the West Indian islands except Jamaica, for more than one co-operative packing house. In Trinidad, for example, one co-operative house in Port-of-Spain can handle fruit from all of the producing areas.

The islands of the West Indies that can produce grapefruit can be considered as an economic unit. Should the industry assume large proportions in these islands, it will be extremely desirable to have a single marketing channel or organization for all of the fruit in order that the islands shall not compete with one another and that *West Indian* grapefruit shall compete as a unit against that from other countries. Co-operation between the islands is essential in such matters as uniformity of grading and varieties if West Indian grapefruit is to gain the place in the markets that it deserves.

The creation of a single brand for all of the islands is not desirable, nor would it prove successful. The writer feels that each island, for the time being, should ship grapefruit under two grades, extra choice and standard, and that each grade in each island should be packed under a distinctive brand. Dominica would ship extra choice and standard grades, we will assume, under the " Dom " and " Forest " brands respectively. Trinidad would also ship under exactly the same grades but would call them " Humming Bird " and " Linnet " brands. Thus, uniformity of grading would be established, yet the fruit of each island would stand on its own merits. The creation of a single brand covering both grades is undesirable because the lower grade will depress the price that the higher grade should realize.

Standard containers should also be adopted. It is suggested that the California type of box is the most suitable.

Any island producing a thousand or more boxes of fruit, with an increase in production a matter of a year or two distant, should consider the advisability of erecting and equipping a centrally-located, co-operative packing house. While such a house, operating on a small scale, cannot handle fruit any more economically than the individual members, the advantages to be derived through such a house are many. The co-operative association can purchase supplies cheaper in large quantities than in small quantities. The members are relieved from the necessity for learning all of the details of fruit packing and handling. Co-operative ownership of field boxes, curing boxes, ladders, clippers and picking bags is more economical than would be the case if every member were to own this equipment himself. The greatest advantage to the growers, however, is in the fact that co-operative packing of fruit insures standardization of grading and packing and general improvement of all handling operations.

If the West Indian islands will plant grapefruit under proper conditions of soil and rainfall, plant the best trees obtainable and give them proper attention, pick, pack and grade the fruit in the best manner, there is no reason why they cannot supply ever-increasing quantities of grapefruit to the United Kingdom and Canadian markets. Natural conditions of soil and climate are unsurpassed—the future of the industry lies with the growers.

IMPORTATION OF CITRUS MATERIAL.

In view of the risk of introducing dangerous citrus diseases and insect pests it is advisable that any bud-wood or other material for propagation required from other countries should only be obtained through the local Departments of Agriculture and with the fullest precautions to ensure their freedom from diseases and pests.

NOTES ON COLONIES VISITED.

(1) BAHAMA ISLANDS.

The Bahama Islands are a chain of islands with a total area of 4,403 square miles, lying south-east of Florida. The soil is very shallow as a rule, consisting for the most part of pockets of varying size and depth in the limestone rock. The rainfall varies from 30 inches to 60 inches.

Although the Bahamas were once the site of a small citrus fruit industry, the present production of oranges and grapefruit is not sufficient to meet the local demand. The largest export was probably in 1905-06, when 2,000,000 oranges were exported. On the basis of 150 fruits per box, this quantity equalled somewhat over 13,000 boxes. The export trade gradually declined because of increasing competition with Florida and California. The McKinley tariff added a further handicap to the trade. With the introduction into the Colony, about 1912, of the blue grey citrus fly (syn. black fly) *Aleurocanthus woglumi*, the bulk of the citrus fruit plantings were killed.

Soil and rainfall conditions throughout the Bahamas are not suited to citrus fruit growing on a commercial scale. There are very few places where any depth of soil is found. The existing soil is rich in organic matter when first cleared from the native bush and is very fertile. The fertility is due largely to the content of organic matter and is quickly exhausted. When crops are planted, the vegetative growth is kept down and the organic content of the soil is depleted rapidly. Any plantings of fruit that are set out for local market purposes must be heavily fertilized, preferably with organic manures.

The depredations of the blue-grey fly were undoubtedly intensified because of a weak condition of the trees resulting from low rainfall, depleted soil fertility and general neglect. The insect can be controlled by frequent sprayings but the operation is costly.

The distribution by the Board of Agriculture of some 6,000 trees during the past two years (1927–28) will undoubtedly increase the quantity of fruit available for the local market. Further efforts should be made to increase the local fruit production, but there seems no possibility of re-establishing an export trade in oranges and grapefruit.

(2) BRITISH HONDURAS.

The colony of British Honduras offers an excellent opportunity for individuals or companies desiring to take up grapefruit growing. The colony is south of the Mexican province of Yucatan, has an area of 8,598 square miles and is heavily wooded. Along the coast the land is low lying and generally poorly drained.

Soils along the lower reaches of the Sibun and Belize rivers are too heavy, too shallow and too poorly drained to justify any large-scale planting of citrus fruits on them. Sandy soils of the " pine ridge " type are found some distance in from the coast. While they can be used for citrus fruit production their light nature and low content of organic matter necessitate heavy fertilization, with a resulting increase in production costs. Until better soils have been fully developed, it would seem unwise to use the sandy soils.

The most suitable area for grapefruit production in British Honduras is in the Stann Creek Valley. In addition to possessing an abundance of excellent soil, the valley has a railway service to the coast that greatly facilitates the transport of fruit. Rainfall in this area varies from 75 inches to 100 inches per year, generally increasing as one goes further inland.

There is no direct communication with England but fruit can be shipped via New York with transhipment at that point. Shipments to Canada would be transhipped at Kingston, Jamaica.

Labour is not as plentiful as in some of the West Indian Islands and is generally paid about $1 (4*s.* 2*d.*) a day, which is much higher than in the West Indies.

The bearing acreage of budded grapefruit trees is small, less than 25 acres, but considerable new acreage is being planted and production will increase rapidly in the near future. Owing to the very low production costs and the high quality of the fruit that is produced, extension of the industry is fully warranted.

Though in certain areas in the country there are small plantings of seedling grapefruit, the seedling tree is undesirable in every way and no further planting of seedlings should be made.

The fruit produced by seedling trees is variable in shape, flavour, quality and other points, and is generally much inferior to the uniform fruit from budded trees of standard varieties. The shipment of seedling grapefruit from British Honduras or from any other Colony, should be stopped, as in view of the severe competition in the large markets it is of the utmost importance that producing Colonies should develop a reputation for uniform fruit of high quality. Such a reputation cannot be acquired if seedling grapefruit are exported and the writer would urge that in British Honduras and the West Indies growers should confine their plantings to the Marsh and Duncan varieties.

An agricultural officer with citrus fruit experience has been appointed to the Forestry Service of British Honduras and planters are thus assured of having available a source of reliable information on production and handling problems.

(3) DOMINICA.

Dominica is one of the Leeward Islands and has an area of 291 square miles. It is one of the most mountainous of the West Indian islands, the mountains rising very abruptly from the sea. The rainfall varies from 60 inches to 300 inches, the rainfall in the mountains being much greater than along the leeward coast.

Road communication in the island is not as good as in some of the other islands.

The climate, while quite warm in summer, is not unduly unhealthy and can be considered as better than in some of the other islands.

The chief agricultural enterprise of the island is the cultivation of the seedling West Indian lime, limes and lime-products such as fresh limes, lime oil, concentrated lime juice and raw lime juice forming about 80 per cent. of the exports from the island.

Since the advent of the " wither-tip " disease of the lime (*Gloeosporium limetticolum*) in 1922, the estimated acreage in limes has fallen from 6,000 acres to 3,500 acres. Lime cultivation in the districts more than a mile from the leeward coast has been entirely abandoned due to the ravages of wither-tip. Along the leeward coast from Soufriere to Portsmouth is a belt of land subject to rainfall much lower than that occurring further inland. In this belt the losses from wither-tip have not been so severe as to render lime cultivation unprofitable. In the mountainous interior it is not likely that commercial production of the West Indian lime will ever again prove profitable because of the losses from wither-tip.

Beginning about September, 1927, a new trouble became epidemic, that known as " red root." Many thousand trees have been lost during the last year and many more will be lost. " Red-root " does not affect lime trees budded on the sour orange root stock and trees lost through " red-root " should be replaced with trees budded on this stock.

As the lime industry has suffered great losses through wither-tip and " red-root", it is essential that a substitute industry be found without delay. The island is admirably suited to the development of a large grapefruit industry, having a suitable climate and an abundance of good grapefruit soil.

The present production of grapefruit is about 500 boxes a year. A small increase will take place in the next two or three years but there is little likelihood of any marked expansion under present conditions. Grapefruit cultivation should be confined to those areas where lime growing is no longer possible. The grapefruit is not attacked by wither-tip and when budded on the sour orange root stock, as it should be, is immune to " red-root."

Although Dominica is pre-eminently adapted to grapefruit cultivation on a large scale, it does not seem likely that any great development will take place in the near future as there are practically no individuals in the island who can carry out the planting. Climatic conditions are suitable, the grapefruit thriving under rainfall as high as 200 inches, soil conditions are excellent and shipping facilities exist for the transport of the fruit to England or Canada, but there is a complete lack of local people with the necessary capital to start the industry.

Capital of £5,000 is necessary for the planting and care of about 20 acres of grapefruit from the initial stages to commercial bearing five years later. Settlers with this amount of capital are not numerous and it would seem that the only chance for creating a grapefruit industry in Dominica lies in the field of company development.

(4) GRENADA.

The island of Grenada in the Windward group, has an area of 120 square miles. It is mountainous, heavily wooded, and has a rainfall varying from 35 inches to 200 inches. There is an unknown quantity of soil suitable for grapefruit culture. The bulk of the best soil is planted to nutmegs and cacao, but several hundred acres could no doubt be found that could be planted to grapefruit. Soils in general are heavy.

Grenada has no citrus fruit industry at present, but during the last two years (1927–28) the Agricultural Department has distributed about 4,000 budded grapefruit plants. Some of these have been sent out in lots of 50 or less and can be disregarded from commercial consideration. There are about 3,000 plants in commercial groves and the production in five years' time will be about 5,000 boxes of fruit. Further planting on a moderate scale is to be expected.

As Grenada is directly associated with Trinidad in agricultural matters, the experience of Trinidad in the development of its grapefruit industry will always be promptly communicated to the planters in Grenada.

(5) JAMAICA.

The island of Jamaica, with an area of 4,207 square miles, lies just south of the eastern portion of Cuba. The present export of grapefruit is approximately 100,000 cases a year and an extension of the industry will probably take place in the near future.

Cultural conditions are most favourable and fruit of high eating quality is produced. The appearance of much of the fruit is poor, chiefly due to the presence of the " black fly," *Aleurocanthus woglumi*. With careful washing and polishing of the fruit, its appearance is greatly improved.

The bulk of the Jamaican plantings are owned by peasant proprietors, with holdings of five acres or less. In holdings of this size grapefruit and other citrus fruits are not grown as a distinct crop but occupy land that is also used for such crops as bananas, coffee, tannias, etc. The result is that little care is given the trees and the quantity and quality of the fruit produced leaves much to be desired.

The bulk of the larger plantings of ten to twenty acres have not been given sufficient care in recent years to maintain them in good condition. Cattle are usually run through the plantings, no fertilization is followed and little or no attempt is made to control insect pests. The result is an unthrifty condition of the trees, low production of fruit and the production of scaley and dirty fruit. This neglect has come about through the loss of the American market due to the McKinley tariff and a lack of direct communication with England.

The growing of seedling trees is greatly to be deplored. Thousands of seedling trees have been planted throughout the island and Jamaican grapefruit is generally very variable. Budded trees of the standard varieties should be planted and seedling trees should be top-worked to these same varieties.

General cultural costs are lower than in California, Florida or South Africa, and fruit can be landed in the United Kingdom markets at a very reasonable figure. While the Elders and Fyffes line will not carry fruit for growers, the creation of a new shipping service, as is contemplated at present, will undoubtedly stimulate further grapefruit production.

The recent establishment of a fruit inspection service by the Government will greatly improve grading and packing standards and is to be highly commended. Handling conditions in the field and packing houses leave much to be desired, the fruit being treated in such a way as to be bruised and injured excessively. As the Florida production of grapefruit is increasing rapidly and as this fruit has a distinct market preference on the basis of excellent quality, appearance, grading and packing, it is very important that Jamaican and other West Indian shippers should ship fruit equal in all respects to that of their most serious competitor.

While large extension of planting in Jamaica is not recommended for the present, the export of grapefruit from the island can be at least doubled through giving more attention and care to the existing groves. Spraying for the control of rust mite, thrips and black fly, cleaning the trees of dead wood, lichens and wild pines, fertilization, improvement of picking and packing operations and general care of the plantings will result in a marked increase in the quantity and quality of the fruit shipped.

(6) ST. LUCIA.

The island of St. Lucia is one of the group known as the Windward Islands. It is a small island, having an area of only 233 square miles but, as is so true of the West Indies as a whole, it is very beautiful. It is mountainous for the most part but in some of the valleys is to be found a limited quantity of soil that is suited to citrus fruit growing.

There is no grapefruit industry in St. Lucia at present but a recent importation of trees was made that will form the nucleus for a small export trade in the near future. The quantity of land in St. Lucia that is available for commercial grapefruit plantings is very limited and it is not to be expected that a large fruit industry will ever be established. Most of the valleys that open out to the sea are of heavy soil with a high-water table.

There is no direct shipping communication with England but a good service exists with Canada. As Canada has established a preferential tariff of 1c. a pound in favour of grapefruit from the West Indies, it would seem possible for St. Lucia to produce a few thousand boxes of grapefruit for shipment to that market. With low cost of production and a preferential tariff, there is no reason why St. Lucia cannot find in Canada a ready market for grapefruit, provided it is of good quality, well graded and well packed.

Barbados with a population of 175,000 is only about 100 miles distant and a considerable quantity of fruits such as the orange, papaya and mango can be readily marketed there. Selected varieties of these fruits should be planted and they should be packed and handled with great care. Under present conditions it would be comparatively easy for St. Lucia to gain the reputation of being the source of supply of the best fruit entering Barbados.

(7) TRINIDAD.

The island of Trinidad with an area of 1,862 square miles, is the southernmost island of the West Indies and lies a few miles off the coast of Venezuela north of the mouth of the Orinoco.

With a population of some 350,000, extensive sugar, cacao and coconut industries and important oil fields, it is one of the most fortunate of the West Indian islands. The rainfall varies from 50 inches to 100 inches or over. The soil is generally very fertile and the quantity of land that can be utilized for agricultural purposes is large. Sections of the island are mountainous, but fertile valleys are plentiful and the extent of rolling and flat land is large. Soils in general are rather heavy except in the southern portion of the island.

The road system of Trinidad is excellent. The presence in the island of the Pitch Lake, the source of the bulk of the world's supply of asphalt, makes possible the building of good roads at a low cost.

Shipping communication with England is good and is of sufficient extent to handle all of the fruit that will be produced for some years to come. The journey from Trinidad to England takes about 14 days and, with careful handling and packing, grapefruit for the English markets need not be refrigerated in transit.

The grapefruit industry is small at present but planters are very anxious to extend their holdings. There are 2,450 bearing trees (35 acres), 11,924 non-bearing trees (168 acres) and approximately 30,000 trees (400 acres) will be planted in 1929. From an export of about 3,000 boxes of fruit in 1928, it is evident that in five or six years the export should reach approximately 75,000 boxes.

Increase in production can continue to an unknown degree should economic conditions justify it. The area of land that is available in Trinidad and suitable for grapefruit culture is unknown, but it is certainly several thousand acres in extent.

It would seem advisable to encourage plantings in the northern and central portions of the Island because (1) these areas have a greater quantity of suitable soil than the southern part of the island; (2) proximity to Port-of-Spain, the point of export, means lower inland transport charges; (3) proximity to Port-of-Spain is a big factor that will result in the successful operation of a central co-operative packing house at that point.

Steps have been taken by the Fruit Growers' Association to form a small co-operative company for the purpose of erecting and equipping a packing house to handle the fruit of the members. Successful operation of such a house will mean uniformity of grading and packing and the shipment of the bulk of the fruit under two brands only, all of which are points of the utmost importance in establishing a new fruit industry.

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